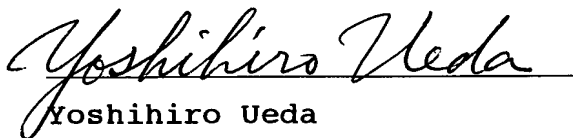


I, Yoshihiro Ueda, of 4-17, Sasano-cho 2-chome,
Hitachinaka-shi, Ibaraki-ken 312-0018, Japan certify that to
the best of my knowledge and belief the following is a true
translation made by me of the annexed document which is a certified
copy of Japanese Patent Application Hei 8-136159 filed on May
30, 1996.

Date this 18th day of October 2001


Yoshihiro Ueda



[Name of document] Specification

[Title of the Invention] CIRCUIT TAPE HAVING ADHESIVE FILM,
SEMICONDUCTOR DEVICE AND A METHOD FOR MANUFACTURING THE SAME

[Claims]

[Claim 1]

A semiconductor device, wherein
circuit tape having a pattern layer and a semiconductor element
are electrically connected,

external terminals for connecting electrically said
circuit tape and a mounting substrate is provided on said circuit
tape, and

film material is used as the material for adhering said
circuit tape and said semiconductor element with insulation,
further wherein

elastic modulus of said film material for adhesion in the
temperature range (200 - 250 °C) of mounting reflow condition
is at least 1 MPa.

[Claim 2]

A semiconductor device as claimed in claim 1 , wherein said
film material is composed of a three layer structure having a
supporter and two adhesive layers applied onto both surfaces
of said supporter.

[Claim 3]

A semiconductor device as claimed in claim 1 , wherein said
film material is composed of a porous supporter , wherein an
adhesive agent is impregnated.

[Claim 4]

Circuit tape comprising

a base material made of dielectric film, whereon a plurality
of metallic patterns are provided, and

an adhesive layer which can be adhered to semiconductor
element with insulation in a condition that said circuit tape

can be connected to said semiconductor, wherein

said adhesive layer is composed of film material, and elastic modulus as a physical property of said adhesive layer in the temperature range (200 - 250 °C) of mounting reflow condition is at least 1 MPa.

[Claim 5]

Circuit tape as claimed in claim 4, wherein

said dielectric insulating layer having said adhesive layer is made of polyimide material, and

said metallic patterns conductive layer is made of copper.

[Claim 6]

Circuit tape as claimed in claim 4, wherein

said metallic patterns conductive layer is composed of a multilayer structure.

[Claim 7]

A semiconductor device as claimed in claim 1, wherein

said circuit tape material having a pattern layer as claimed in claim 1 and a semiconductor element are electrically connected by connecting leads comprising circuits formed on said circuit tape.

[Claim 8]

A semiconductor device as claimed in claim 1, wherein

said circuit tape material having a pattern layer as claimed in claim 1 and a semiconductor element are electrically connected by wire bonding.

[Claim 9]

A method for manufacturing semiconductor device comprising the steps of,

- (1) forming an adhesive layer on tape having a pattern layer,
- (2) adhering said tape having the pattern layer to semiconductor element with insulation via said adhesive layer,
- (3) connecting electrically said pattern layer formed on

said circuit tape to pads on said semiconductor element,

(4) encapsulating the electrically connected portion with insulating material, and

(5) forming external terminals for connecting to mounting substrate on said circuit tape.

[Claim 10]

A method for manufacturing semiconductor device comprising the steps of,

(1) forming an adhesive layer on a semiconductor element,

(2) adhering tape having a pattern layer to said semiconductor element with insulation via said adhesive layer,

(3) connecting electrically said pattern layer formed on said circuit tape to pads on said semiconductor element,

(4) encapsulating the electrically connected portion with insulating material, and

(5) forming external terminals for connecting to mounting substrate on said circuit tape.

[Claim 11]

A method for manufacturing semiconductor device comprising the steps of,

(1) registering tape having a pattern layer and a semiconductor element,

(2) adhering said tape having said pattern layer to said semiconductor element with insulation via an adhesive layer simultaneously,

(3) connecting electrically said pattern layer formed on said tape to pads on said semiconductor element,

(4) encapsulating the electrically connected portion with insulating material, and

(5) forming external terminals for connecting to mounting substrate on said circuit tape.

[Detailed description of the invention]

[0001]

[Technical field of the invention]

The present invention relates to circuit tape, semiconductor device, and a method for manufacturing the same, which are superior in electrical characteristics, mounting reliability, and assembling easiness, and are responsible to requirement for high density mounting, multipins mounting, and fast transmittance.

[0002]

[Prior art]

Currently, in accordance with improving electronic members to high performance, requirement for high integration and high density mounting of semiconductor has become strong. Therefore, semiconductor elements have been improved to of high integration and high performance such as LSI, VLSI, and ULSI, and increasing capacity, the number of pins, speed, and consuming power of the element have been advanced. In responding to the above requirement, the package structure of the semiconductor device for multipins has been changed from the structure, in which connecting terminals are provided at two sides of the element, to the advanced structure, in which the connecting terminals are provided at all four sides of the element. Furthermore, in order to respond to increasing the number of pins, a grid array structure has come to be used practically. The grid array structure means a structure of semiconductor element, in which the connecting terminals are provided at grid array on all the mounting surface of the element by using a multilayer carrier substrate. In the grid array structure contains the ball grid array structure (BGA), which has shortened connecting terminal length in order to make fast signal transmission possible. The ball type structure of the connecting terminal increases width of its conductor. therefore, the ball structure is also effective

in decreasing inductance. Currently, in order to response to the requirement for fast signal transmission, organic materials having a relatively low dielectric constant are studied as the multilayer carrier substrate. However, the organic materials have generally a larger thermal expansion coefficient than semiconductor element, and thermal stress generated by the difference in thermal expansion becomes problems in connection reliability, and so on. Recently, a structure which does not use the carrier substrate has been proposed for the BGA package. That is, a new semiconductor element package structure is disclosed (US Patent 5,148,265), in which the connection reliability is improved by using elastomer material of low elastic modulus for reducing the thermal stress generated by the difference in thermal expansion of the semiconductor element and the mounting substrate. The above package structure uses circuit tape composed of polyimide and the like instead of carrier substrate for electrically connecting the semiconductor element and the mounting substrate. Therefore, the electrically connecting points between the semiconductor and the circuit tape are connected by wire bonding method or bonding connection with leads, and between the circuit tape and the mounting substrate are electrically connected by soldering ball terminals. As the elastomer material of prior art, silicone material is generally used in view of material of low elastic modulus and superior in heat resistance. As a general method for forming a stress buffer layer with silicone material, the steps of printing uncured liquid resin on the circuit tape using masks, and subsequently, curing the printed resin, are generally used. The above method has problems such as difficulty in maintaining flatness of the buffer layer obtained by the printing, and complexity of the printing process which requires a long time for the printing. Accordingly, the above method is not suitable

for mass-production process, and the problems in assembling yield and reliability of mounting caused by the difficulty in maintaining flatness of the buffer layer must be solved.

[0003]

[The problem to be solved by the invention]

The object of the present invention is to provide a method for obtaining a stress buffer layer superior in flatness by using film material as the elastomer material for reducing the thermal stress in semiconductor devices, and semiconductor devices superior in mass productivity.

[0004]

[The measures to solve the problem]

In order to realize the above object, the present invention provides the following measures. The measures can be achieved by providing a semiconductor device comprising circuit tape having a pattern layer connected electrically to a semiconductor element, an external terminal provided on the circuit tape for connecting electrically the circuit tape to a mounting substrate, and film material for adhering the circuit tape to the semiconductor element with maintaining insulation between the circuit tape and the semiconductor element, wherein the film material for adhering has a physical property such that the elastic modulus of the film material in the temperature range of solder reflow condition for mounting (200 - 250 °C) is at least 1 MPa.

[0005]

The above film material for adhering is passed through a process for forming the external terminal such as solder ball and the like for connecting the mounting substrate and the circuit tape, or a solder reflow process for mounting the semiconductor element of the present invention onto the mounting substrate in the manufacturing process of the semiconductor devices. The

reflow temperature is generally a high temperature in the range of 200 - 250 °C. Therefore, if the semiconductor device contains moisture, the moisture evaporates during the heat treatment, and the film material swells by vapor pressure of moisture. When the swelling exceeds a threshold value, a foaming phenomenon is generated, and defects such as void formation, delamination, and the like are generated. Therefore, the film material to be used is required to have a low moisture absorption rate as possible, and a high modulus of elasticity in the range of reflow temperature. In accordance with the present invention, various film materials were studied, and it was found that the adhesive materials, of which elastic modulus in the temperature range of reflow process was at least 1 MPa, had superior reflow characteristics. A several examples of temperature dependence of the elastic modulus of the material are shown in FIG. 1.

[0006]

Furthermore, it was found that when the materials, of which elastic modulus in the temperature range of mounting reflow condition was maintained at least 1 MPa, was used, a preferable result in the anti-reflow characteristics could be obtained. The amount of swelling depends on the ratio of vapor pressure and the elastic modulus, and the higher the elastic modulus is, the less is the amount of swelling. The foaming phenomenon is generated when the amount of swelling exceeds the break elongation, one of mechanical properties of the material. Furthermore, the elastic modulus correlates with the mechanical strength of the adhesive film material, and generally, the higher the elastic modulus is, there is a tendency to increase break stress and break elongation. Therefore, by using the material having a high elastic modulus in the range of reflow temperature, the reflow characteristics can be improved in both the swelling amount and the mechanical characteristics. In the above case,

the adhesive film material is any of thermosetting resin or thermoplastic resin.

[0007]

The adhesive layer is sometimes composed of any of sticky adhesive agents and sticky-cohesive adhesive agents, in addition to the adhesive agents made of the above material. In order to maintain at least 1 MPa of elastic modulus in the temperature range of reflow process, the thermoplastic resin preferably has a glass transition temperature, i.e. a changing point of elastic modulus, higher than the temperature range (200 - 250 °C) of reflow process. The thermosetting resin is required to have a chemical or physical crosslinking structure in a certain degree at a temperature in the rubber region, which is higher than the glass transition temperature. That is, the elastic modulus in the rubber region is generally proportional to the crosslinking density, and the crosslinking density must be increased in order to increase the elastic modulus. The film material is desirably composed of a low elastic modulus resin having an elastic modulus of utmost 4000 MPa at room temperature in order to operate as the stress buffer layer.

[0008]

As one of characteristics of film material, the coefficient of moisture absorption at 85 °C/85 % RH for 168 hours is desirably utmost 3 % in view of reflow characteristics. As the film material, low elastic modulus materials except silicone material can be used. Structure of the film material is not restricted to the homogeneous structure composed of the adhesive agent component, but also, for instance, three layers structure having two adhesive layers at both surfaces of a supporter respectively, a structure in which the adhesive agent is impregnated into a porous supporter can be used. As shapes of the film, various shapes manufactured by stamping, a mesh-like

shape, and the like can be used. The mesh-like shape is effective in improving anti-reflow property at moisture absorbed time, because adhesion area can be decreased.

[0009]

In a case of multilayer structure represented by the three layer structure, the supporter and the adhesive layer can be composed of a combination of at least two kinds of the above adhesive agents, the sticky adhesive agents, the sticky-cohesive adhesive agents, and the like. The adhesive layer locates at each of both the surfaces of the supporter, and each of the adhesive layer can be formed by different kind of material from each other. For instance a combination is usable, in which a thermosetting resin having a high fluidity is used in order to flatten the unevenness of pattern layer of the circuit tape side, and a thermoplastic resin, which can be adhered in a short time at a high temperature, is used at the opposite flat portion for adhering the semiconductor element.

[0010]

A set of schematic illustrations indicating a flow of general fabrication process of semiconductor device of the present invention is shown in FIG. 2. The process can be divided into three representative sections. The first one (FIG. 2-a) is a method for fabricating semiconductor element comprising the steps of (1) the step for adhering adhesive film to the tape having pattern layer, (2) the step for adhering the tape having pattern layer to the semiconductor element by the adhesive film with maintaining the insulating condition, (3) the step for connecting electrically the pattern layer formed on the tape and the pad on the semiconductor element, (4) the step for sealing the electrically connected portion with an insulating agent, (5) the step for forming an external terminal on the tape for connecting to the mounting substrate.

[0011]

The method mentioned above is effective in improving processability, because the circuit tape and the film material can be handled in a manner of reel to reel process, as explained later. The second one (FIG. 2-b) is a method for fabricating semiconductor element comprising the steps of (1) the step for adhering adhesive film to the semiconductor element, (2) the step for adhering the tape having pattern layer to the semiconductor element by the adhesive film with maintaining the insulating condition, (3) the step for connecting electrically the pattern layer formed on the tape and the pad on the semiconductor element, (4) the step for sealing the electrically connected portion with an insulating agent, (5) the step for forming an external terminal on the tape for connecting to the mounting substrate. The above method is effective in improving the production yield of the semiconductor element itself. In accordance with the method, the stress buffer layer can be formed on the semiconductor element at the wafer stage condition.

[0012]

The third one (FIG. 2-c) is a method for fabricating semiconductor element comprising the steps of (1) the step for setting the tape having the pattern layer in register and adhering the tape to the semiconductor element by the adhesive film simultaneously with maintaining the insulating condition, (2) the step for connecting electrically the pattern layer formed on the tape and the pad on the semiconductor element, (3) the step for sealing the electrically connected portion with an insulating agent, (4) the step for forming an external terminal on the tape for connecting to the mounting substrate. The above method is effective in shortening the manufacturing time, because the number of the steps in the process can be decreased.

[0013]

These methods essentially comprises the following steps . The adhesive film material of the present invention is provided between the tape material having the pattern layer and the semiconductor element by a certain method, and adheres the tape material and the semiconductor element simultaneously or sequentially with conditions of designated temperature, pressure, and time. Subsequently, the pattern layer on the tape is electrically connected to the connecting pad of the semiconductor element. As the connecting method using connecting lead previously formed on the circuit tape as a circuit for connecting with the semiconductor element, any one of a single point bonding method, a gang bonding method, and the like is used.

[0014]

As another method for connection, a method in which the pattern layer and the semiconductor element are connected with wire bonding is used. Then, the connecting portion is encapsulated with insulating material, and finally the external terminals , which are electrically connecting terminal with the mounting substrate, are formed on the circuit tape. As the external terminal, solder ball is generally used, and most of the solder ball is formed by plating. Metals for the plating are gold, nickel, copper, solder, and the like .

[0015]

In order to improved mass productivity in the manufacturing process, the process for integrating the adhesive film material with the circuit tape previously as shown in FIG. 2-a is important.

[0016]

As a general method for the above process, a method comprising the steps of transferring the tape, whereon the pattern is formed, by a long reel apparatus, stamping out

the adhesive film into a designated shape, and adhering the adhesive film of the designated shape onto the circuit tape as shown in FIG. 3 is effective for mass production. When the adhesive film is made of thermosetting resin, the adhesive film is adhered to the circuit tape in a condition of uncured A stage or half-cured B stage. The resin is further cured to a condition of final-cured C stage during the step of adhering the obtained circuit tape attached with the adhesive film to the semiconductor element. Otherwise, if the adhesive agent reaches to the condition of final cured C stage during the adhesive film is adhered to the circuit tape, sometimes, the adhesive layer is newly formed on the cured film portion.

[0017]

As a method for forming the adhesive layer, application method, film adhering method, and the like are generally used.

The adhesive component is desirably not sticky at room temperature, but if sticky, mold releasing paper, and the like is used.

[0018]

FIG. 4 indicates a composition of the circuit tape attached with adhesive film. The circuit tape can be adhered to the semiconductor element. If thermosetting resin is used for the adhesive layer at the circuit tape side, and thermoplastic resin is used for the adhesive layer at the side adhered to the semiconductor, the circuit tape having the adhesive ability shown in FIG. 4 can be provided readily.

[0019]

When the adhesive layer is composed of thermoplastic, sticky, or cohesive material, the conditions for the two steps to adhere with the circuit tape and with the semiconductor element can be set as quite the same each other. Different from the case of thermosetting resin, the curing reaction does not require

to be controlled at intermediate stages, and the manufacturing process superior in workability can be provided .

[0020]

When the adhesive layer is composed of sticky or cohesive material, the material is advantageous in view of warp of the semiconductor element, because the material can be adhered at room temperature. When the adhesive film is previously combined with the circuit tape, the semiconductor element is readily registered at adhering to the circuit tape. Accordingly, jigs of adhering apparatus can be simplified, and the method becomes advantageous for mass production.

[0021]

With the semiconductor device relating to the present invention, the unevenness of the pattern circuit on the circuit tape is sometimes filled with the adhesive layer of the film. In this case, suitability of the adhesive layer for the filling can be confirmed at the step of combining the circuit tape. Therefore, unsuitable adhesive layer can be eliminated before adhering to the semiconductor element, Loss of the semiconductor can be avoided, and it is advantageous in increasing the production yield.

[0022]

Typical thermosetting resin and thermoplastic resin for composing the adhesive component of the film materials are as follows: epoxy resin polyimide resin, polyamide resin, cyanate resin, isocyanate resin, fluorine-containing resin, silicon-containing resin, urethane resin, acrylate resin, styrene resin, maleimide resin, phenolic resin, unsaturated polyester resin, diallyl phthalate resin, cyanamide resin, polybutadiene resin, polyamideimide resin, polyether resin, polysulfone resin, polyester resin, polyolefine resin, polystyrene resin, polyvinyl chloride, trans-polyisoprene

resin, polyacetal resin, polycarbonate resin, polyphenylene ether resin, polyphenylene sulfide resin, polyacrylate resin, polyether imide resin, polyether sulfone resin, polyether ketone resin, liquid crystalline polyester resin, polyallylether nitrile resin, polybenzoimidazole resin, various kinds of polymer blend, and polymer alloys, and the like.

[0023]

The above thermosetting resin and the thermoplastic resin are the material having adhesiveness with melting or softening by heating.

[0024]

On the contrary, the sticky or cohesive materials are the material having adhesiveness by pressurizing. Typical examples of the sticky and cohesive materials are as follows: various rubber groups such as silicone group, butadiene group and isoprene group, acrylate groups, polyvinyl ether groups, and the like. The cohesive material includes a room temperature curing type, a type cured by heat, ultraviolet ray irradiation, electron beam irradiation, and the like, a type cured by concurrent use of accelerator, and the like. The room temperature curing type includes a moisture-reactive type which reacts in the presence of moisture in the atmosphere, a photo-reactive type which contains photo-initiator, and an anti-oxygen material which contains peroxide, and the like. The thermosetting resin generally includes a crosslinking agent such as thiurum groups, phenol groups, isocyanate groups, and the like, and adhesive components are crosslinked three-dimensionally to form the adhesive layer at a designated temperature.

[0025]

The material of the type cured by ultraviolet ray irradiation, or electron beam irradiation, contains various

photo-initiators. The material of the type cured by concurrent use of the accelerator includes a solution containing a reaction accelerator and a crosslinking agent, which are applied onto the surface of the sticky layer, and forms finally the adhesive layer by mixing the above two agents with a contact pressure and reacting the two agents sequentially. For the cohesive agent of the present invention, the thermosetting resin is relatively preferable. Using the thermosetting resin, the semiconductor device, which is superior in mass productivity and reliability, can be provided by the method comprising the steps of registering the circuit tape and the semiconductor element at room temperature, contacting the wiring tape and the semiconductor element to form a set, and elevating the temperature of a plurality of the sets to a designated degree simultaneously in a container such as a constant temperature bath for proceeding the curing reaction to ensure adhesive strength.

[0026]

Elastic modulus of the adhesive film material is preferably high at a high temperature region in view of reflow characteristics, but low as possible at room temperature. Because, the semiconductor element and the mounting substrate generally have different thermal expansion coefficients from each other, and a thermal stress is generated, when the mounting is performed, at the external terminal which is composed of solder ball and the like. Then, reliability of the connection becomes remarkably important.

[0027]

If the elastic modulus of the adhesive film existing between the semiconductor element and the mounting substrate is low, the region of the adhesive layer becomes a stress buffer layer, and it is advantageous in view of connection reliability. The elastic modulus at room temperature is desirably utmost 4000

MPa, further preferably, the elastic modulus in all the range of heat cycling test (-55°C - 150°C) is utmost 2000 MPa. As the material which has a high elastic modulus at a high temperature and a relatively low elastic modulus in a range of low temperature including room temperature, sometimes silicone group materials are used. The film material comprising the silicone group material is one of the significantly important materials of the present invention.

[0028]

However, the film materials other than the silicone group material having the above characteristics are advantageous in comparison with the silicone group material. That is, because of weak cohesive energy of silicon, cyclic low molecular weight silicone group compounds are gradually decomposed thermally during a long time heat treatment such as storing at a high temperature (for instance, at least 150°C), and sometimes become an origin of contamination to environment.

[0029]

The composition of the film material of the present invention is not only a homogeneous structure composed of the adhesive agent components, but also a three layer structure such as a supporter having each of adhesive agent layers at both surfaces for instance, and a structure in which the adhesive agent is impregnated into a porous supporter. As the supporter of the film material, films or porous material made of polyimide, epoxy, polyethylene terephthalate, cellulose, acetate, fluorine-containing polymer, and the like can be used.

[0030]

As the shape of the film, the various shapes obtainable by stamping out, a mesh-like shape, and the like can be used. The mesh-like shape is effective in improving anti-reflow property at moisture absorbed time, because adhesion area can

be decreased. The three layer structure can be controlled arbitrary in thickness and the kind of the adhesive layer at both the surfaces of the supporter, and fluidity of the adhesive layer at the adhesion can be readily controlled. Furthermore, the insulating layer is ensured by the supporter located at the intermediate location between the adhesive layers.

[0031]

The value of vapor pressure of the adhesive material by moisture absorption at the reflow can be maintained low by using material, of which film material has a coefficient of moisture absorption at 85 °C/85 % RH of utmost 3 %, and a preferable reflow characteristics can be obtained.

[0032]

The tape having a pattern layer is generally composed of a flexible circuit substrate. That is, polyimide group material as the insulating layer, epoxy group material, polyimide group material, phenolic group material, polyamide group material, and the like are used as the adhesive layer with the conductor. Generally, copper is used as the conductor. As the wiring circuit, the copper is sometimes coated with nickel, gold plating, and the like. As the flexible circuit substrate, the material, which does not use the adhesive layer with the conductor, but copper layer is formed directly onto the polyimide insulating layer, is sometimes used. The tape having a pattern layer is sometimes composed of multilayer wiring structure. In this case, a voltage layer, a ground layer, and so on in addition to the signal layer can be formed in the circuit tape, and the semiconductor device superior in electric characteristics can be provided.

[0033]

Typical two arranging structures of the pad terminal on the semiconductor element for connecting electrically the tape

material having the pattern layer with the semiconductor element are as follows.

[0034]

The one is a peripheral pad arranging structure as shown in FIG. 5. In this case, there are types of structure as the arranging structure of the external terminal of the semiconductor device as shown in FIG. 6. That is the case wherein the external terminals locate under the semiconductor element (Fan In type, FIG. 6-1), the case wherein the external terminals locate outside the semiconductor element (Fan Out type, FIG. 6-2) and the case wherein the external terminals locate at both underside and outside the semiconductor element (Fan In/Out type, FIG. 6-3) can be used.

[0035]

As another case of the pad arranging structure, the central arranging structure as shown in FIG. 7 can be used. In this case, the semiconductor device is composed of the structure shown in FIG. 8.

[0036]

In accordance with the present invention, the semiconductor element means the device wherein IC, LSI and the like such as memorial logics, gate array customs, power transistors and the like are formed on the wafer comprising semiconductors such as Si, GaAs and the like, and the device has terminals for connecting to lead, bump, and the like.

[0037]

In accordance with the present invention, the semiconductor device comprising the tape having the pattern layer is used as an interconnection between the semiconductor element and the mounting substrate, which is superior in anti-reflow characteristics and connection reliability, has become to be provided by using the film material having an elastic modulus

of at least 1 MPa in the reflow temperature region (200 - 250 °C) , which is a high temperature region as the adhesive material in a condition of maintaining the insulation between the circuit tape and the semiconductor element. By using the film material, the manufacturing method superior in mass productivity to the conventional printing methods has become to be provided.

[0038]

[Description of the Preferred Embodiments]

(Embodiment 1)

Epoxy group adhesive film (made by Hitachi Chemical Co. Ltd., AS 3000, 50 μ m thick) was registered, placed, and adhered between a semiconductor element and circuit tape at 170 °C for one minute with pressure of 50 kgf/cm², and post-cured at 180 °C for 60 minutes in a constant temperature bath. Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by single point bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hitachi Chemical Co. Ltd., RC021C). Finally, the semiconductor device shown in FIG. 6-1 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0039]

After absorbing moisture in a constant temperature bath at 85 °C/85% RH for 168 hours, the obtained semiconductor device was set in an infrared reflow apparatus of maximum temperature at 245 °C, and confirmed the semiconductor device whether defects such as delamination and voids by foaming the adhesive layer were generated or not. Furthermore, the connection reliability between the lead of the semiconductor device and the solder bump was confirmed. In this case, a woven glass-epoxy copper clad laminate FR-4 (made by Hitachi Chemical Co. Ltd., MCL-E-67) was

used as the mounting substrate. The reliability was evaluated by performing thermal cycling test ($-55^{\circ}\text{C} \leftarrow \rightarrow 150^{\circ}\text{C}$, 1000 times). (Embodiment 2)

Film material having a three layer structure was obtained by applying an adhesive agent (made by Hitachi Chemical Co. Ltd., DF335), composed of die bonding film material, onto both surfaces of polyimide film (made by Ube Kosan Co. Ltd., SGA, $50\text{ }\mu\text{m}$ thick) by $50\text{ }\mu\text{m}$ thick, respectively. The obtained film material was registered, and adhered to circuit tape at 170°C for five seconds with pressure of 30 kgf/cm^2 . With the above condition, unadhered adhesive layer had a sufficient adhesive force to adhere the semiconductor element.

[0040]

The circuit tape attached with the film material was adhered to the semiconductor element at 200°C for one minute with pressure of 30 kgf/cm^2 , and post-cured at 200°C for 60 minutes in a constant temperature bath. Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hitachi Chemical Co. Ltd., RC021C). Finally, the semiconductor device shown in FIG. 6-2 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0041]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0042]

(Embodiment 3)

Low elastic adhesive film composed of epoxy resin and

acrylic rubber (made by Hitachi Chemical Co. Ltd., trial product, 150 μm thick) was registered, placed, and adhered between the semiconductor element and the circuit tape at 180 °C for 30 seconds with pressure of 100 kgf/cm², and post-cured at 180 °C for 60 minutes in a constant temperature bath. Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by wire bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toshiba Silicone Co. Ltd., TSJ 3150). Finally, the semiconductor device shown in FIG. 6-3 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0043]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1 .

[0044]

(Embodiment 4)

Film material having a three layer structure was obtained by adhering low elastic adhesive film composed of epoxy resin and acrylic rubber (made by Hitachi Chemical Co. Ltd., trial product, 50 μm thick) to both surfaces of woven glass-epoxy resin laminate (obtained by eliminating copper clad by etching from both surfaces of MCL-E-679 made by Hitachi Chemical Co. Ltd.).

[0045]

The film material was registered, placed, and adhered between the semiconductor element and the circuit tape at 200 °C for 20 seconds with pressure of 80 kgf/cm², and post-cured at 180 °C for 60 minutes in a constant temperature bath. Subsequently, connecting leads on the circuit tape were

electrically connected to pads of the semiconductor element by single point bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toshiba Silicone Co. Ltd., TSJ 3153) . Finally, the semiconductor device shown in FIG. 8 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0046]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0047]

(Embodiment 5)

LOC Film (made by Hitachi Chemical Co. Ltd., HM122U, 100 μ m thick) having a three layer structure was registered, and adhered to the circuit tape at 300 °C for 2 seconds with pressure of 150 kgf/cm². In the adhering process, the film was stamped out into a designated shape using the long scale apparatus shown in FIG. 3, and the stamped film was adhered to the circuit tape continuously. Because the adhesive layer of the film was made of thermoplastic resin, the unadhered portion of the adhesive layer still had a sufficient adhering force to the semiconductor element.

[0048]

The circuit tape adhered with the film material was adhered to the semiconductor element at 300 °C for 10 minutes with pressure of 100 kgf/cm². Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by single point bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hokuriku Toryo Co. Ltd. Chip coat 8107). Finally, the semiconductor device shown in FIG. 6-1 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the

circuit tape.

[0049]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0050]

(Embodiment 6)

Thermoplastic polyimide film (made by Mitsui Toatsu Chemicals, Inc., Regulus PI-UAY, 100 μ m thick) was registered, and adhered to the semiconductor element at 250 °C for 2 seconds with pressure of 30 kgf/cm². The film had a sufficient adhesive force to adhere the circuit tape.

[0051]

The semiconductor element adhered with the film material was adhered to the circuit tape at 250 °C for 10 seconds with pressure of 20 kgf/cm². Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by wire bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hokuriku Toryo Co., Ltd. Chip coat 8107). Finally, the semiconductor device shown in FIG. 6-2 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0052]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0053]

(Embodiment 7)

Film material composed of a three layer structure having two different kinds of adhesive layers was obtained by applying a fluorine-containing polyimide (a reactant of

hexafluorobisphenol AF and bis(4-aminophenoxyphenyl) hexafluoropropane, glass transition temperature 260°C) onto the one surface of polyimide film (made by Ube Kosan Co. Ltd., SGA, $50\text{ }\mu\text{m}$ thick) by $50\text{ }\mu\text{m}$ thick, and a polyetheretherketone (a reactant of dihydroxy-naphthalene and difluorobenzophenone, glass transition temperature 154°C) onto the other surface of the polyimide film by $50\text{ }\mu\text{m}$ thick.

[0054]

The obtained film material was registered, and adhered to circuit tape using the adhesive layer having the lower glass transition temperature. The adhesion condition was at 200°C for one minute with pressure of 30 kgf/cm^2 . Because the adhesive layer of the film was composed of thermoplastic resin, the adhesive layer had a sufficient adhering force to adhere the semiconductor element. The circuit tape attached with the film material was adhered to the semiconductor element at 300°C for ten seconds with pressure of 80 kgf/cm^2 . Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hokuriku Toryo Co. Ltd., Chip coat 8107). Finally, the semiconductor device shown in FIG. 6-3 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0055]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0056]

(Embodiment 8)

Silicone adhesive agent (made by Shinetsu Chemical Co. Ltd..

KE1820) was applied onto the one surface of silicone film (made by Toray Dow Corning Silicone Co. Ltd., JCR6126, 150 μm thick, press-fabrication) by 20 μm thick. Then, the silicone film was registered, and adhered to circuit tape. The adhesion condition was at 150 °C for one minute with pressure of 30 kgf/cm². Furthermore, in order to adhere semiconductor element, the silicone adhesive agent (made by Shinetsu Chemical Co. Ltd., KE1820) was applied onto the other surface of the silicone film by 20 μm thick, and the circuit tape attached with the film material was adhered to the semiconductor element. The adhesion condition was at 200 °C for 30 seconds with pressure of 20 kgf/cm². Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toray Dow Corning Silicone Co. Ltd., DA 6501). Finally, the semiconductor device shown in FIG. 8 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0057]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0058]

(Embodiment 9)

Porous polytetrafluoroethylene (made by Japan Gore-tex Inc., 190 μm thick), both surfaces of which were applied with BT resin (Bismaleimide-Triazine resin), was registered, and adhered to circuit tape. The adhesion condition was at 150 °C for one minute with pressure of 30 kgf/cm². Because the adhesive layer of the film was in a B stage condition (half-cured condition), the adhesive layer had a sufficient adhering force to adhere

semiconductor element.

[0059]

The adhesion condition of the circuit tape attached with the film material to the semiconductor element was at 200 °C for 2 minutes with pressure of 70 kgf/cm². Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The connecting portion was encapsulated with an epoxy encapsulant (made by Hitachi Chemical Co. Ltd., R021C). Finally, the semiconductor device shown in FIG. 6-1 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0060]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0061]

(Embodiment 10)

Sticky tape having a three layer structure (made by Teraoka Seisakusyo. Ltd., Tape No. 760, 145 μm thick, silicone adhesive agent was applied onto both surfaces of Kapton film (commercial name by Du Pont)) was registered, and adhered to circuit tape at room temperature for 5 seconds with pressure of 50 kgf/cm². In the adhering process, the film was stamped out into a designated shape using the long scale apparatus shown in FIG. 3, and the stamped film was adhered to the circuit tape continuously. Because the adhesive layer of the film was made of sticky resin, the unadhered portion of the adhesive layer still had a sufficient adhering force to the semiconductor element.

[0062]

The circuit tape adhered with the film material was adhered

to the semiconductor element at room temperature for 10 seconds with pressure of 5 kgf/cm². Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by single point bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toshiba Silicone Co. Ltd. TSJ 3150). Finally, the semiconductor device shown in FIG. 6-2 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0063]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0064]

(Embodiment 11)

Cohesive tape having a three layer structure (150 μ m thick, butadiene adhesive agent was applied onto both surfaces of unwoven aramide cloth (100 μ m thick)) was registered, and adhered between semiconductor and circuit tape at room temperature for 5 seconds with pressure of 50 kgf/cm². In the above condition, somewhat correction of the registration was possible, because the adhesive layer was still in a cohesive condition. Then, the adhesive layer of the film was cured at 180 °C for 60 minutes in a constant temperature bath to form a connecting state of three dimensional crosslinking structure, because the adhesive layer was made of cohesive resin.

[0065]

Subsequently, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by single point bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toshiba Silicone Co. Ltd., TSJ 3150). Finally, the semiconductor device shown in FIG. 6-3

was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0066]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0067]

(Embodiment 12)

Polyamic acid was prepared by reacting an equivalent of benzophenonetetracarboxylic acid dianhydride (made by Wako Pure Chemicals) and bis(4-(2-aminophenoxyphenyl)ether) (synthetic chemical) at 5°C in dimethylacetamide. Then, the reactant was heated to 250 °C for obtaining polyimide. The obtained polyimide 100 g was mixed with 4,4',-glycidyl-3,3,5,5'- tetramethyl biphenylether (made by Yuka Shell) 19.5 g, phenol novolac (made by Meiwa Kasei) 10.6 g, and triphenylphosphate (made by Wako Pure Chemicals) 0.2 g as a catalyst in dimethylacetamide to obtain a varnish containing non-volatile component of 20 % by weight. Film of 100 μ m thick was prepared with the obtained varnish.

[0068]

The prepared film was registered, and adhered to circuit tape. The adhesion condition was at 170 °C for ten seconds with pressure of 30 kgf/cm². In the above condition, the unadhered portion of the adhesive layer had a sufficient adhering force to adhere with semiconductor element. The adhesion condition of the circuit tape attached with the film material to the semiconductor element was at 200 °C for one minute with pressure of 30 kgf/cm². Subsequently, post-curing was performed at 200 °C for 60 minutes in a constant temperature bath. Then, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The

connecting portion was encapsulated with an epoxy encapsulant (made by Hitachi Chemical Co. Ltd., RC021C). Finally, the semiconductor device shown in FIG. 6-2 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0069]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0070]

(Embodiment 13)

Film having a three layer structure was prepared by applying the varnish obtained in the embodiment 12 onto the one surface of polyimide film (made by Ube Kosan Co. Ltd., SGAf 50 μm thick) by 20 μm thick (thermosetting resin component), and the fluorine-containing polyimide, i.e. a varnish prepared in the embodiment 7, (the reactant of hexafluorobisphenol AF and bis (4-aminophenoxyphenyl) hexafluoropropane, glass transition temperature 260 °C) onto the other surface of the polyimide film by 10 μm thick (thermoplastic resin component). The film was registered and adhered to circuit tape at the surface where the thermosetting resin component was applied.

[0071]

The adhesion condition was at 170 °C for 10 seconds with pressure of 30 kgf/cm². Then, post-curing was performed at 200 °C for 60 minutes in a constant temperature bath. Subsequently, semiconductor element was adhered to the surface where the thermoplastic resin component was applied. The adhesion condition was at 350 °C for 2 seconds with pressure of 80 kgf/cm². Then, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding.

The connecting portion was encapsulated with an epoxy encapsulant (made by Hokuriku Toryo chip coat 8107). Finally, the semiconductor device shown in FIG. 6-2 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0072]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0073]

(Comparative example 1)

An elastomer of 150 μm thick was formed by registering silicone resin (made by Toray Dow Corning Silicone Co. Ltd., JCR 6126) to circuit tape, and printing using metal masks. After the formation, post-curing was performed at 150 °C for 60 minutes in a constant temperature bath. Then, flatness of the elastomer was determined by a laser film thickness measuring apparatus. A silicone adhesive agent (made by Sinetsu Chemical Co. Ltd., KE 1820) was applied onto surface of the elastomer by 20 μm thick as an adhesive layer for adhering semiconductor element to the circuit tape having the elastomer, and the circuit tape was registered and adhered to the semiconductor element.

[0074]

The adhesion condition was at 150 °C for one minute with pressure of 30 kgf/cm². Then, connecting leads on the circuit tape were electrically connected to pads of the semiconductor element by gang bonding. The connecting portion was encapsulated with a silicone encapsulant (made by Toshiba Silicone, TSJ 3150). Finally, the semiconductor device shown in FIG. 6-1 was obtained by fixing the solder balls, which were connecting terminals with the mounting substrate, onto the circuit tape.

[0075]

The reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0076]

(Comparative example 2)

Film having a three layer structure was prepared by applying thermoplastic resin (polyamide 12, m.p. 175 °C) having a melting point equal to or lower than 200 °C onto both surfaces of polyimide film (made by Ube Kosan Co. Ltd., SGA, 50 μ m thick) as adhesive layers (30 μ m thick). The film having the three layer structure was used to prepare semiconductor device by the same method as the embodiment 1, and the reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0077]

(Comparative example 3)

Film having a three layer structure was prepared by applying epoxy resin (made by Hitachi Chemical Co. Ltd., R021C) having a high elastic modulus at room temperature onto both surfaces of polyimide film (made by Ube Kosan Co. Ltd., SGA) as adhesive layers (20 μ m thick). The film having the three layer structure was used to prepare semiconductor device by the same method as the embodiment 1, and the reflow characteristics and connection reliability of the lead and the solder bump of the obtained semiconductor device were confirmed by the same method as the embodiment 1.

[0078]

Table 1

[Table 1]

	Elastic modulus (MPa)		Reflow test	Thermal cycling test(1000 cycles)	
	Adhesive film (25°C)	Adhesive layers (average of 200 ~ 250 °C)		Lead open failure (%)	Bump open failure (%)
Emb.* 1	788	4.3	No void	0	0
Emb. 2	5000	1.5	No void	0	0
Emb. 3	960	3.6	No void	0	0
Emb. 4	4190	3.6	No void	0	0
Emb. 5	3750	13	No void	0	0
Emb. 6	3500	100	No void	0	0
Emb. 7	3500	2000, 15	No void	0	0
Emb 8	10	2.5	No void	0	0
Emb. 9	2000	100	No void	0	0
Emb. 10	20	2.5	No void	0	0
Emb. 11	30	3.5	No void	0	0
Emb. 12	850	8.5	No void	0	0
Emb. 13	3300	2000, 8.5	No void	0	0
Com.*1	10	2.5	No void	10	0
Com. 2	1400	~ 0	Void	5	0
Com. 3	11000	1100	No void	80	100

*: Embodiment , *: Comparative example.

Flatness of the elastomer: High and low difference of comparative example 1 was 50 μ m to thickness of 150 μ m, and all other samples within 5 μ m.

[0079]

[Advantages of the invention]

In accordance with the present invention, the semiconductor device, wherein the tape material having the circuit layer and the semiconductor element are electrically connected, the external terminal for connecting electrically with the mounting substrate is provided on the circuit tape, and film material is used as the material for adhering the circuit tape and the semiconductor element with insulation, superior in anti-reflow property can be provided by using film material for the adhesion, of which elastic modulus in the reflow temperature range is at least 1 MPa. A manufacturing method superior in mass productivity can be provided by using film material at a portion for buffering thermal stress generated by difference in thermal expansion of the semiconductor element and the mounting substrate.

[0080]

The film material is superior in flatness, and the high and low difference within 5 μm can be ensured to the thickness of 150 μm , and a manufacturing method superior in workability can be provided. In accordance with the stress buffering effect of the film material, connection reliability of both the lead portion connecting electrically the circuit tape and the semiconductor element, and the bump connecting electrically the semiconductor device and the mounting substrate can be satisfied simultaneously in a temperature cycling test.

[Brief Description of the Drawings]

[FIG. 1]

A graph indicating temperature dependency of the elastic modulus of materials.

[FIG. 2]

Schematic illustrations indicating the manufacturing process of the semiconductor device of the present invention,

(2-a) is the manufacturing method wherein the film is adhered previously to the circuit tape, (2-b) is the manufacturing method wherein the film is adhered previously to the semiconductor element, and (2-c) is the manufacturing method wherein the circuit tape and the semiconductor element are adhered together simultaneously via the film.

[FIG. 3]

A schematic illustration indicating the continuous process for adhering the film using the long reel.

[FIG. 4]

A schematic cross section indicating the composition of the circuit tape having the film with the adhesive agent layer.

[FIG. 5]

A schematic plain view of the semiconductor element having the peripheral pads.

[FIG. 6]

Schematic cross sections indicating the structure of semiconductor devices using the semiconductor elements having the peripheral pads.

[FIG. 7]

A schematic illustration indicating the semiconductor element having the pads locating at the center of the element.

[FIG. 8]

A schematic cross section indicating the structure of the semiconductor device using the semiconductor element having the pads locating at the center of the element.

[Description of the marks]

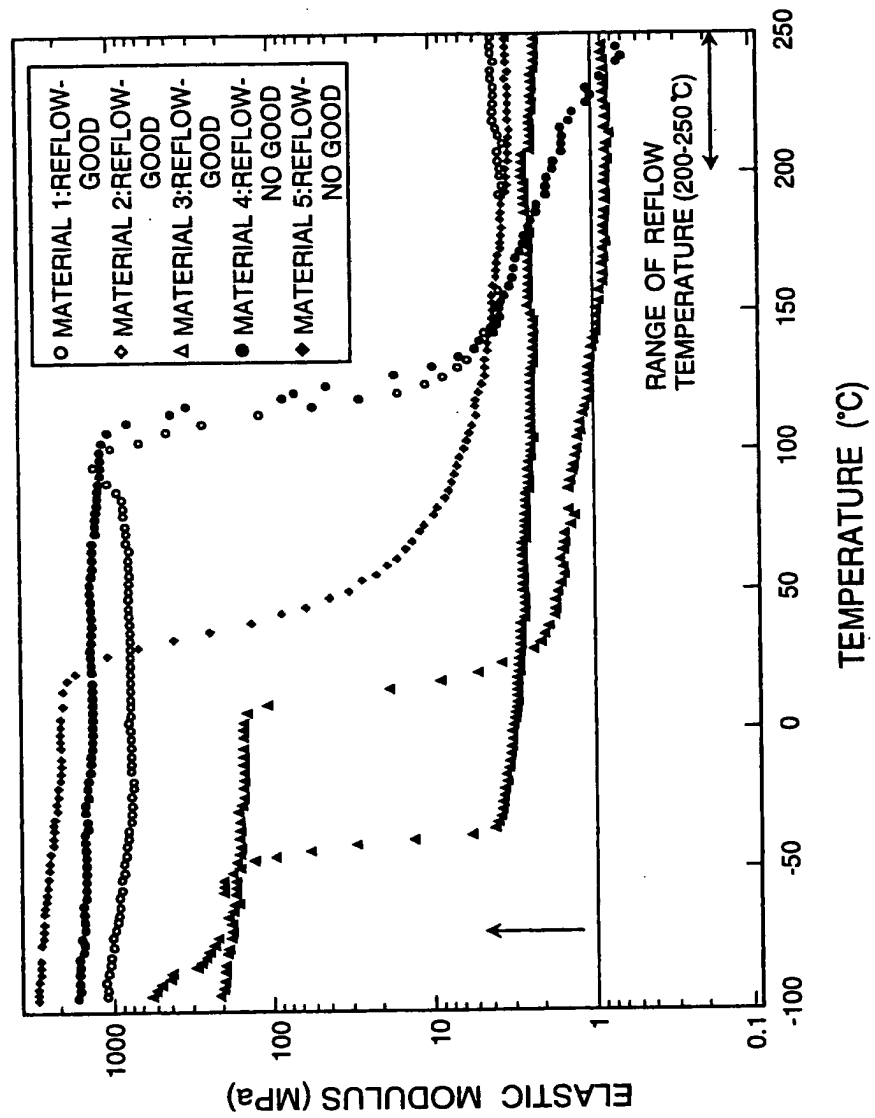
2.1, 4.1, 6.1, 8.1...CIRCUIT TAPE, 2.1.1...LEAD
CONNECTED TO BUMP, 2.2, 4.2, 6.2, 8.2...BUFFER BODY FILM, 2.3,
5.1, 6.3, 7.1, 8.3...SEMICONDUCTOR ELEMENT, 2.4, 6.4,
8.4...ENCAPSULANT RESIN, 2.5, 6.5, 8.5...EXTERNAL TERMINALS
(SOLDER BUMP), 3.1...LONG REEL OF CIRCUIT TAPE, 3.2...LONG

REEL OF FILM, 3.3...PUNCHING JIG, 3.4...FILM FORMED ON
CIRCUIT TAPE, 4.1.1...LEAD FORMED ON CIRCUIT TAPE,
4.3...ADHESIVE AGENT LAYER, 5.1.1, 7.1.1...CONNECTING PAD,
6.6...OUTER FRAME (HEAT SPREADER ET AL.).

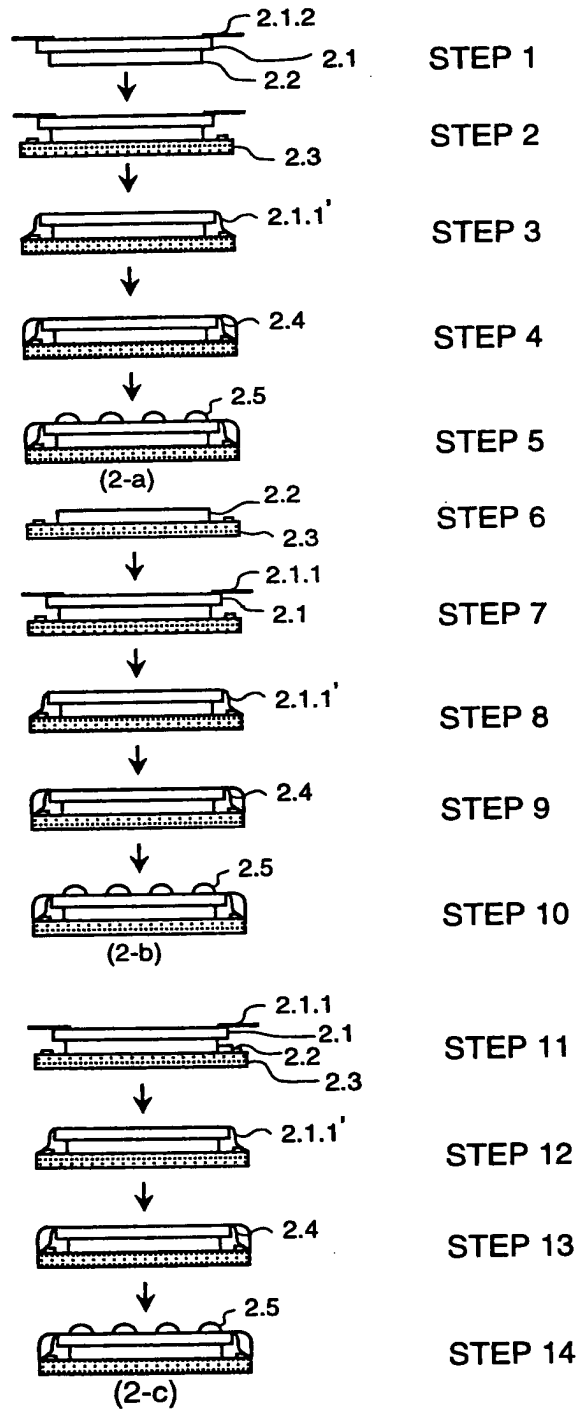
[Name of document] Drawings

[FIG. 1]

FIG. 1



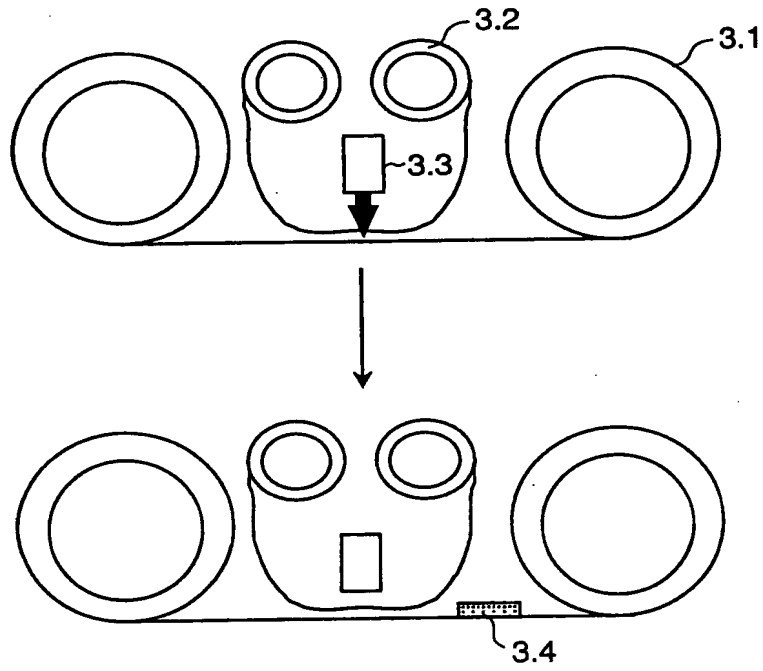
[FIG. 2]

FIG.2

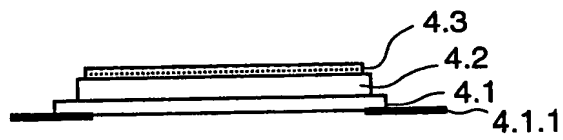
[FIG. 2] (Remarks)

- Step 1: A step for adhering an adhesive tape to a tape having a circuit layer.
- Step 2: A step for adhering a semiconductor element insulatingly to a tape having a circuit layer via an adhesive tape.
- Step 3: A step for connecting circuit layer formed on the tape electrically to a pad on the semiconductor element.
- Step 4: A step for encapsulating the electrically connected portion with insulating material.
- Step 5: A step for forming external terminals for connecting to a mounting substrate on the tape.
- Step 6: A step for adhering an adhesive tape onto the semiconductor element.
- Step 7: A step for adhering a semiconductor element insulatingly to a tape having a circuit layer via an adhesive tape.
- Step 8: A step for connecting circuit layer formed on the tape electrically to a pad on the semiconductor element.
- Step 9: A step for encapsulating the electrically connected portion with insulating material.
- Step 10: A step for forming external terminals for connecting to a mounting substrate on the tape.
- Step 11: A step for adhering a semiconductor element insulatingly to a tape having a circuit layer via an adhesive tape integrally after registration.
- Step 12: A step for connecting circuit layer formed on the tape electrically to a pad on the semiconductor element.
- Step 13: A step for encapsulating the electrically connected portion with insulating material.
- Step 14: A step for forming external terminals for connecting to a mounting substrate on the tape.

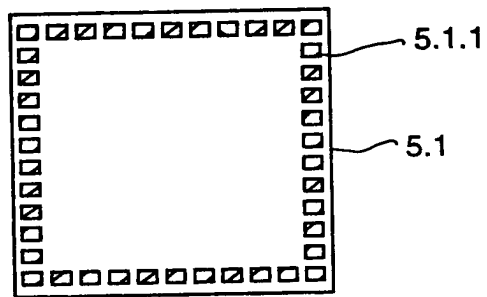
{FIG. 3}

FIG.3

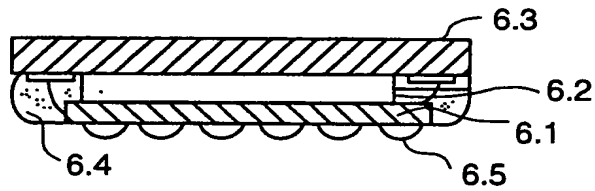
[FIG. 4]

FIG.4

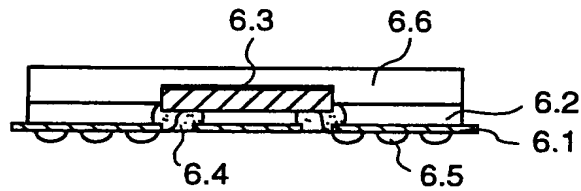
[FIG. 5]

FIG.5

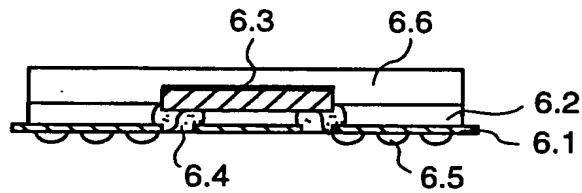
[FIG. 6]

FIG.6

(6-1) Fan In TYPE

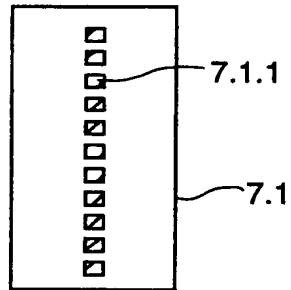


(6-2) Fan Out TYPE

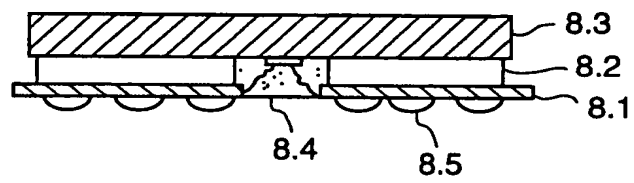


(6-3) Fan In/Out TYPE

[FIG. 7]

FIG.7

[FIG. 8]

FIG.8

[Name of document] Abstract of the disclosure

[Abstract]

[Issues]

The object of the present invention is to provide a semiconductor device having a superior connection reliability by providing a buffer body for absorbing difference of thermal expansion between the mounting substrate and the semiconductor element in a semiconductor package structure, even if an organic material is used for the mounting substrate.

[Measures to solve the issues]

As the body for buffering a thermal stress generated by difference of thermal expansion between the mounting substrate and the semiconductor element, film material is used. The film material is characterized in having an elastic modulus of at least 1 MPa in the reflow temperature range (200 - 250 °C).

[Selected drawing] FIG. 2